A 1960-44 (A) 1
10/87

AIP report
EDUCATION AND EMPLOYMENT STATISTICS DIVISION

American Institute of Physics, 335 East 45th Street, New York, NY 10017
Telephone (212) 661-9404
Telex 960983/AMINSTPHYS-NYK

1985–86 GRADUATE STUDENT SURVEY

by Susanne D. Ellis

AIP Pub. No. R-207.19 September, 1987

The expected increase in the demand for physicists directs attention toward the educational pipeline which, in the case of physics students, extends over approximately six years of postbaccalaureate training. During those years the potential physicists choose their specialties and are expected to complete a doctorate. Since graduate training is essential to becoming a physicist, the size and composition of the graduate student population is closely monitored. Since 1980, we find that the number of graduate students has increased by 25% (from 9,600 to 12,000), and the educational backgrounds of the students have become increasingly diverse. The details of those changing trends are examined annually by our Graduate Student Survey to which individual physics and astronomy students contribute their information. The ratio of physics to astronomy students is 17:1, which accounts for the disproportionate number of pages in this report devoted to the analysis of physics students. The characteristics and career goals of astronomy students are analyzed in a similar format, provided the number of respondents to specific questions was large enough to be meaningful. Highlights of this report are:

- ➤The proportion of foreign graduate students at all levels is now 38%.
- ➤The proportion of new 'postdocs' increased dramatically both among U.S. and foreign degree recipients.
- ➤Fewer foreign doctorate recipients were able to secure potentially permanent employment in the U.S.
- ➤More women, both U.S. and foreign, were granted graduate physics degrees.

Figures I and **II** measure the demand for new physicists in terms of the employment offers new graduates received and present such analyses over the five-year period from 1981 to 1986. For each of the two groups of graduate degree recipients the numbers of employment offers are divided into three categories: no offer, one offer and multiple offers. To interpret the information provided by these figures correctly we need to take into account a major limitation of the increasing proportion of foreign students among the graduates. Since their visas make them ineligible for potentially permanent employment in the U.S., we include temporary postdoctoral fellowships with offers of regular employment. Thus **Figure I** can be interpreted as showing a high demand for new doctoral physicists. The demand for new physics masters, presented in **Figure II**, is not as high and appears to have declined for the class of 1986. This conclusion is based on the recent increase in the "zero job offers" category as well as the substantial decline (from 38% to 15%) in the proportion of masters who reported multiple offers.

Figure I. Employment offers for new physics doctorate recipients, 1981–1986.

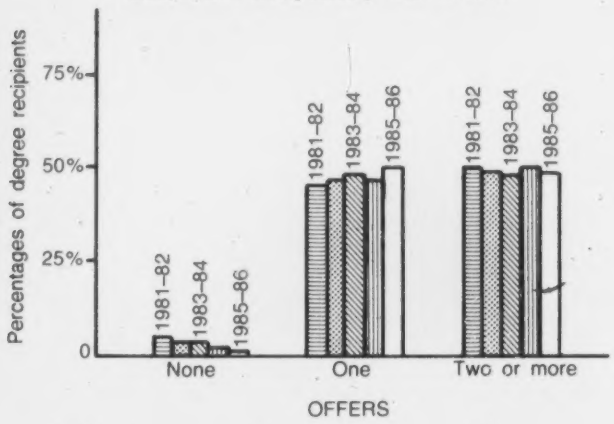
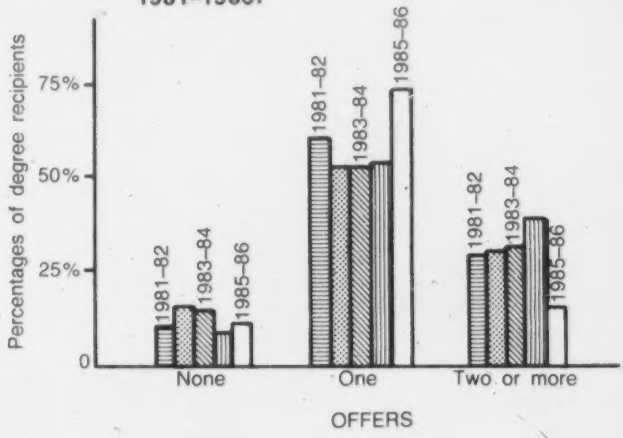


Figure II. Employment offers for new masters, 1981–1986.



MEMBER SOCIETIES:
AMERICAN PHYSICAL SOCIETY • OPTICAL SOCIETY OF AMERICA • ACOUSTICAL SOCIETY OF AMERICA • SOCIETY OF RHEOLOGY • AMERICAN ASSOCIATION OF PHYSICS TEACHERS • AMERICAN CRYSTALLOGRAPHIC ASSOCIATION • AMERICAN ASTRONOMICAL SOCIETY • AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE • AMERICAN VACUUM SOCIETY • AMERICAN GEOPHYSICAL UNION

Table I. Characteristics of the graduate physics student population, 1985–86.

Characteristics		All graduate students	First-year graduate students	Degree recipients: Terminal masters	Degree recipients: Doctorate recipients
	*Total population:	12 011	2981	704	1051
	Number of respondents:	6 790	1347	277	623
Sex	Female	13%	15%	*16%	*9%
	Male	87	85	84	91
Citizenship	U.S.	*62%	*58%	81%	66%
	Foreign	38	42	19	34
Physics in high school	Yes	93%	92%	85%	94%
	No	7	8	15	6
Major of bachelor's degree	Physics	88%	85%	78%	90%
	Mathematics	2	2	2	3
	Engineering	5	7	13	4
	Other phys. science	2	2	1	2
	Other	3	4	6	1
Type of bachelor's institution	PhD granting	43%	40%	45%	48%
	MS granting	6	7	16	5
	BS/BA granting	16	15	20	14
	Foreign	35	38	19	33
Type of graduate institution*	PhD granting	91%	86%	75%	100%
	MS granting	9	14	25	–
Student status*	Full-time	90%	89%	82%	93%
	Part-time	10	11	18	7
Source of support	Teaching assistantship	34%	55%	44%	10%
	Research assistantship	45	15	26	67
	Fellowship	8	12	2	7
	Employment (part-time)	3	4	5	2
	Family, savings, loan	2	4	5	2
	Other**	8	10	18	12

* *These data were derived from the survey of Enrollments and Degrees.*
** *Includes full-time employment for part-time students.*

Table I presents eight characteristics of the total graduate physics student population as well as those of three subgroups, namely the first-year students, the terminal masters and the doctorate recipients. Our annual survey of Enrollment and Degrees establishes the total population in each of these groups, forming a base for interpreting the responses to the Graduate Student Survey. The first two rows of **Table I** present these numbers.

The changes in distribution by gender may appear to be small, but women interested in becoming physicists recorded increases of one to three percentage-points in each of the four groups of **Table I**. The largest one-year increase was observed among the terminal masters where the proportion rose from 13% to 16%.

The characteristic that has indicated steady changes since the late 1970s is citizenship. Entering graduate physics students from foreign countries doubled their numbers since the mid 1970s and are beginning to emerge from the educational pipeline with doctorates. Consequently the proportion of doctorates conferred on foreign citizens in 1985–86 was three percentage-points higher than that of the previous year. This pattern is likely to continue because the proportion of foreign first-year graduate students is still increasing.

The influx from other disciplines to physics at the graduate level is generally small, as illustrated by the fourth characteristic of **Table I**. Transfer students from engineering form the largest group, especially among the terminal masters. Consistent with the changes mentioned in connection with "citizenship" are the increases in graduate students who came from foreign bachelor's institutions. The ratio of full-time to part-time students has shown little change over the years.

Traditionally, beginning graduate students are offered teaching assistantships until they advance enough to qualify as research assistants. Funds for assistantships in physics have always been plentiful, which is indicated in **Table I** by the small proportion of graduate students who are obliged to use family funds and loans or resort to part-time off-campus employment at any level of study. For more detailed information on sources of support, see **Table IV**.

Almost one-third of the graduate physics students identify themselves as members of a specific minority group; U.S. minorities comprise only 4% of the respondents to this survey. **Table II** lists the minority groups and divides the larger ones on the basis of citizenship: Asian Indians and Arabs are predominantly foreign. Other characteristics, selected for inclusion in **Table II**, are intended to identify similarities and differences between the members of minority

Table II. Characteristics of minority group physics students, 1985–86

Characteristics		Total number:	Black U.S.	Black Foreign	Native American Indian	Hispanic Puerto Rican	Hispanic Mexican American	Other U.S.	Other Foreign	Asian Indian	Oriental U.S.	Oriental Foreign	Arab
			56	29	15	16	14	40	90	406	111	1251	172
Sex		Female	8	1	4	3	2	3	10	94	19	188	21
		Male	48	28	11	13	12	37	80	312	92	1063	151
Candidacy for:		TMS	13	4	3	1	3	3	3	27	8	55	14
		MS and PhD	31	23	7	13	8	28	62	333	69	823	137
		PhD only	12	2	5	2	3	9	25	46	34	373	21
Student status		Full-time	45	28	15	13	14	31	86	401	101	1230	161
		Part-time	11	1	0	3	0	9	4	5	10	21	11
Physics in high school		Yes	38	25	11	14	14	34	86	393	104	1213	168
		No	18	4	4	2	0	6	4	13	7	38	4
Full-time equivalent years of graduate study		<1	11	5	3	2	1	13	14	59	24	212	19
		2	14	8	6	5	7	11	20	75	25	278	34
		3	7	3	1	1	1	4	17	70	23	235	30
		4	4	4	1	2	3	6	15	61	13	218	23
		5	9	3	3	4	1	3	8	62	9	202	34
		6	4	5	–	1	1	2	8	43	13	59	16
		>7	7	1	1	1	–	1	8	36	4	47	16
Major subfields		Elect. at. mol.	7	2	–	2	1	3	7	27	5	103	9
		Elem. particles	7	2	–	2	1	3	7	27	5	103	9
		Math. physics	2	3	–	2	–	3	20	31	7	58	11
		Nuclear	4	8	2	–	–	3	7	35	10	79	24
		Optics/hol.	5	–	1	–	1	1	4	26	4	91	12
		Solid state	21	9	6	6	4	10	28	165	38	565	46
Graduate degree recipients		TMS	20	5	5	3	3	2	4	40	14	59	22
		Doctorates	6	3	2	2	1	6	18	62	10	108	31

groups and the total graduate physics population. An example is the fifth characteristic which illustrates that attrition rates are different because the U.S. minority groups are more likely to be candidates for terminal master's degrees than for doctorates. The last two rows of **Table II** confirm this observation by listing the number of degree recipients in each minority group for 1985–86. Similarities between all graduate physics students and minority students include the proportions in which they chose their subfields.

The data in **Table III** were scaled up to give an estimate of the total number of graduate physics students in each of the major subfields and at nine levels of graduate study. One reason for presenting this type of analysis is to make it possible to estimate the number of graduates in a given subfield who will seek employment within a year or two. Approximately two years of graduate study are required for a terminal master's degree and at least five or six years for a doctorate. Thus **Table III** serves the additional purpose of indicating which subfields are likely to require more time to complete a dissertation. Electron, atomic and molecular physics appears to be an example of such a specialty. By comparing the percentages in the last column with those of the previous year we found that fewer students specialized in astrophysics and plasma physics, whereas geophysics was the subfield chosen by a slightly larger proportion of the graduate students.

Table III. Number of graduate physics students, by subfield and years of graduate study completed, 1985–86.

		Full-time equivalent years of graduate study									Total graduate students	
		< 1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	>9 yrs.	N	%
Distribution of students	N	2981	2355	1860	1585	1535	945	450	170	130	12011**	
	%	24.8	19.6	15.5	13.2	12.8	7.9	3.7	1.4	1.1		100%
Astrophysics		161	104	84	55	61	65	15	3	5	553	4.6
Bio/medical physics		107	94	61	51	41	27	9	3	3	396	3.3
Electron, atomic, molecular		182	128	146	135	144	88	72	16	14	925	7.7
Elem. particles		311	298	253	231	229	118	42	33	10	1525	12.7
Geo/atmospheric physics		128	127	82	62	68	35	17	5	4	528	4.4
Mathematical physics		224	162	140	109	103	42	39	3	8	830	6.9
Nuclear physics		201	184	123	136	148	100	35	20	16	963	8.0
Optics		241	181	115	57	64	33	18	10	3	722	6.0
Plasma/fluid physics		92	68	80	87	74	57	28	8	11	505	4.2
Solid state		838	731	650	593	552	338	163	64	51	3980	33.2
General physics		296	97	44	1	2	2	1	2	1	446	3.7
Other subfields		200	181	82	68	49	40	11	3	4	638	5.3

* *The distribution of students in each subfield is based on 6679 respondents to this question.*

** *The total was derived from the survey of Enrollments and Degrees.*

Table IV. Sources of support for graduate physics students, by sex and degree status, 1985–86.

Source of support	Female	Male	Candidates for: Terminal master's	Master's enroute to PhD	PhD after master's	PhD only	Total N	Total %
Teaching assistantship	39%	35%	46%	49%	27%	34%	2417	36
Research assistantship	40	46	20	30	56	51	3076	45
Fellowship	10	8	4	8	8	11	564	8
Foreign government	2	1	1	2	1	1	95	1
Family, savings, loan	3	2	5	3	2	1	149	2
Part-time employment	2	3	7	3	2	1	177	3
Other, including multiple sources of support	4	5	17*	5	4	1	312	5
	100%	100%	100%	100%	100%	100%		
Total respondents N	892	5898	705	1503	2848	1734	6790	
Total respondents %	13	87	10	22	42	26		100%

* *Includes masters who worked full-time to support their graduate studies.*

Having mentioned that the level of graduate study influences the type of support offered to graduate students, we see in **Table IV**, additional details linking the support to the candidacies for specific degrees. For example, master's degree candidates are likely to be offered teaching assistantships, whereas research assistantships are more prevalent among the advanced students. Since a higher proportion of women than men are terminal master's rather than doctoral candidates, the percentage of women holding teaching assistantships is always greater than that for men. The rapid increase in foreign students prompted us to add "foreign government" to the list of sources of support in **Table IV**; however, the data collected since 1982 indicate that very few foreign students receive financial support from their native countries.

The normal pattern of graduate education in physics consists of two years of course work followed by three or four years of research in an area of concentration that leads to a doctoral dissertation. The intensive professional work, which usually starts in the third year of graduate school, is performed either on an experimental or theoretical basis. An array of doctoral candidates grouped by type of research, subfield and level of graduate study, is presented in **Table V**. The ratio of experimentalists to theoreticians remains at 2:1.

Table V. Number* of advanced graduate physics students specializing in selected experimental or theoretical subfields by years of graduate study completed, 1985–86.

Physics subfield	Type of research	Full-time equivalent years of graduate study: 3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	>9 yrs.	Total N	Total % Exp.	Total % Theo.
Astrophysics	experimental	49	36	38	30	10	2	5	170	3.8	
	theoretical	40	20	18	32	4	2	1	117		5.3
Bio/medical	experimental	49	38	36	28	8	3	3	165	3.7	
Electron, atomic molecular	experimental	106	112	97	65	57	14	14	465	10.4	
	theoretical	32	24	41	24	14	3	1	139		6.3
Elem. particles	experimental	162	140	110	93	35	22	6	568	12.7	
	theoretical	102	100	122	32	10	12	3	381		17.3
Geophysics	experimental	55	44	48	18	16	5	2	188	4.2	
Math. physics	theoretical	140	110	112	44	38	4	8	456		20.7
Nuclear	experimental	69	91	105	85	22	19	11	402	9.0	
	theoretical	52	52	40	18	14	2	5	183		8.3
Optics	experimental	96	51	65	30	16	7	3	268	6.0	
Plasmas	experimental	53	51	38	32	12	6	5	197	4.4	
	theoretical	31	38	38	26	12	2	5	152		6.9
Solid state	experimental	490	430	407	269	142	51	45	1834	41.0	
	theoretical	163	149	139	60	18	9	4	542		24.6
Other subfields	experimental	76	52	28	32	15	6	6	215	4.8	
	theoretical	95	47	53	27	7	1	3	233		10.6
Total	experimental	1205	1045	972	682	333	135	100	4472	100.0%	
	theoretical	655	540	563	263	117	35	30	2203		100.0%

* *The numbers in this table have been scaled up to reflect the total number of graduate students (6675) who completed three or more years of graduate study.*

Table VI. Distribution by subfield and employment offers for doctorate recipients, 1985–86.

Physics subfield		Total in subfield	Employment-oriented graduates	New 'postdocs'	Percentage of graduates within subfield who received: 0 offers	1 offer	>2 offers
Astrophysics		4.6%	2.0%	2.6%	–	31%	69%
Electron, atomic molecular		11.7	4.6	7.1	3%	54	43
Elementary particles		14.2	3.4	10.8	–	51	49
Geo/Geophysics		3.3	1.2	2.1	–	58	42
Math. physics		5.2	1.6	3.6	7	48	45
Nuclear		10.1	4.1	6.0	2	46	52
Optics		3.4	2.1	1.3	–	60	40
Plasmas, fluids		5.0	2.5	2.5	–	50	50
Solid state		37.5	13.9	23.6	1	51	48
All other subfields		5.0	3.0	2.0	–	43	57
Total	%	100.0%	38.4%	61.6%	1%	50%	49%
	N	1038*	399	639			
All experimental subfields			286	392	2%	50%	48%
All theoretical subfields			113	247	1%	49%	50%

* *This total does not include an estimated 13 graduates who were not interested in immediate employment, (see Figure IV). It is the survey of Enrollments and Degrees which supplied this total.*
Note: The "job offer" portion of this table does not include graduates with commitments to foreign employers.

Degree recipients

When the time comes to choose a specialty for the dissertation, many graduate students base such a decision on data that link physics subfields with employment opportunities. **Table VI** provides these correlations by showing the distribution of new doctoral physicists among nine major subfields and relating each subfield to job offers. Without examining the details, it appears that in 1985–86 an already favorable job market has improved even further. However, before drawing that conclusion, we need to focus on the two columns in **Table VI** that describe the two types of initial employment; the number of job offers is based on both types. Acceptance of either a potentially permanent position or a temporary postdoctoral fellowship was counted as a job offer although by and large the former is frequently considered more desirable. In order for foreign graduates to accept regular employment, they need to find an employer willing to go through the legal procedures necessary to convert their student visas to those of permanent residents; otherwise they are only entitled to accept temporary 'postdocs'. The recent increase in foreign doctorate recipients reflects these conditions and resulted in an eleven percentage-point rise in "New postdocs" to almost 62%.

Using "multiple offers" as a measure of demand, one can conclude that five years ago the demand for theoreticians was distinctly lower than that for experimentalists. According to **Table VI** the demand for graduates in the class of 1986 was almost identical for experimentalists or theoreticians.

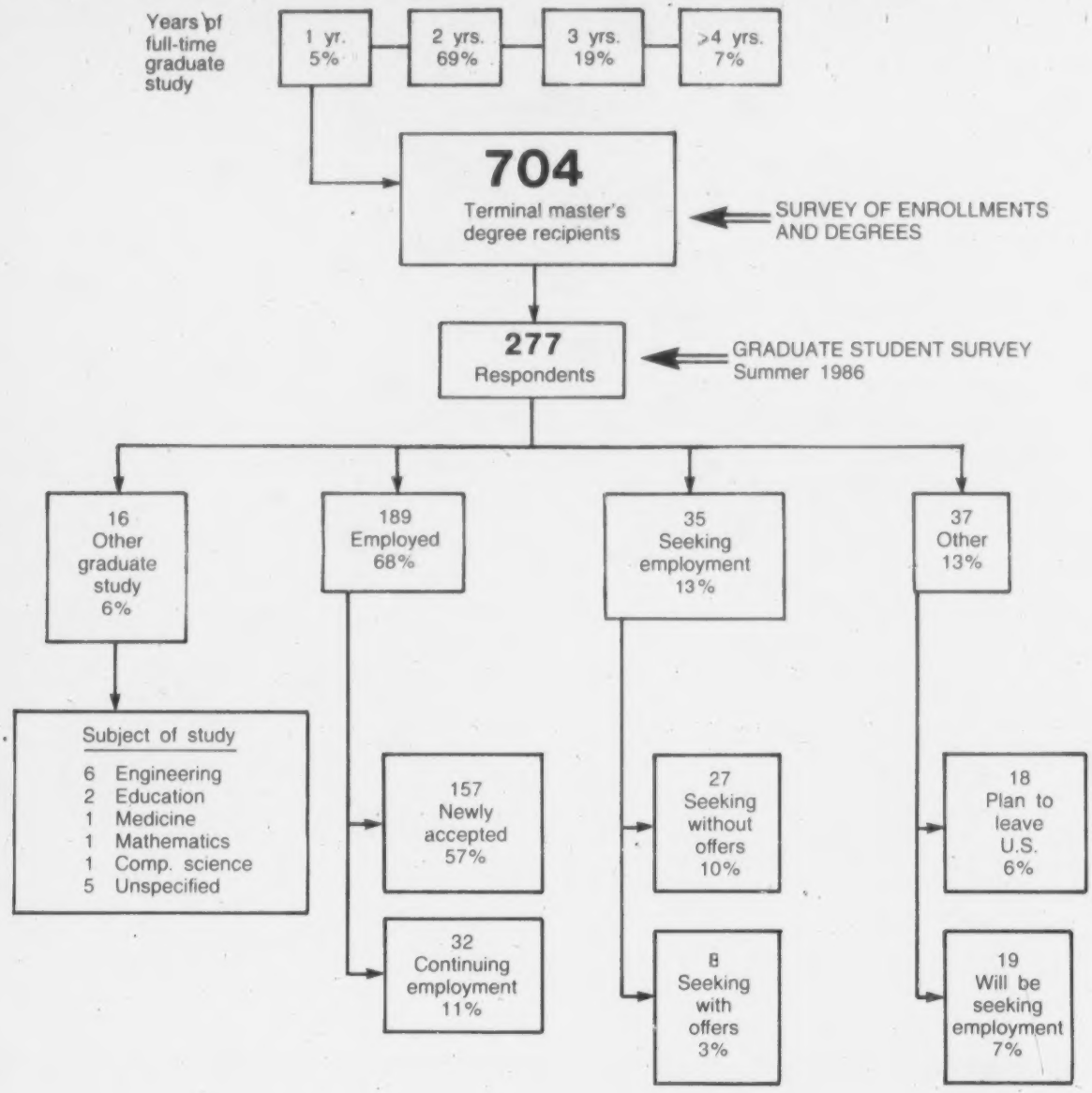
As explained in its footnote, **Table VI** limits its analysis to job offers from U.S. employers. To present a broader view of the demand for physicists we need to include the employment opportunities both in the U.S. and abroad. Thus **Table VII** was designed to focus on the employment exchanges that involve doctoral graduates; specifically, the table outlines what proportion of new physicists remain in the United States for their initial employment irrespective of citizenship, and how many accept their first postdoctoral positions abroad. In the class of 1986, 88% reported employment in the U.S. compared with 84% of a similar graduating class in 1985. However, it should be noted that the increase in new 'postdocs' dominated all other findings. While foreign doctorate recipients increased by 12% between 1985 and 1986, new foreign 'postdocs' with U.S. employment increased by 36%. Similarly, a 5% increase in new U.S. physicists corresponded to a 25% increase in new 'postdocs'. Fewer foreign graduates were able to secure potentially permanent employment in the U.S. (19% of the foreign degree recipients in 1985 decreased to 11% of a similar group in 1986.)

Table VII. Employment of doctoral graduates by citizenship, 1985–86.

Doctoral graduates		U.S. employer 'Postdoc'	U.S. employer Accepted	U.S. employer Cont.	Foreign employer 'Postdoc'	Foreign employer Accepted	Uncommitted	Total N	Total %
U.S. citizens		198	151	21	21	1	11	403	66
Foreign citizens		143	22	1	17	25	4	212	34
Total	N	341	173	22	38	26	15	615	
	%	56	28	4	6	4	2		100%

Note: Seven doctoral graduates had no immediate plans and one graduate reported "other graduate study."

Figure III. Post-degree plans of physics terminal master's degree recipients, 1985–86.



Based on data reported by the physics departments, the total number of terminal master's degrees granted rose sharply between 1985 and 1986. The 12% increase may, in part, be attributable to more students completing their degrees in less time. The first row of data in **Figure III** shows that 74% of the degree recipients required at most two years of graduate study, a seven percentage-point increase over the previous year.

By terminating graduate study at the master's level the student has the option of either continuing graduate work in another discipline or starting employment. **Figure III** shows that close to 90% of the terminal masters in the class of 1986 were employment-oriented while the proportion of masters who changed disciplines of graduate study continued its decline to 6%. Back in 1980, 16% of the graduates had continued their studies in a variety of disciplines. Among the "other subjects of study" the potential engineers continue to outnumber all the others.

The 35 masters who were still seeking employment at the time of the survey included eight who had received offers but had not yet decided to accept them and another eight whose student visas presented obstacles to legal employment in the U.S. The latter group may ultimately be reclassified and added to the 18 graduates who "plan to leave the U.S."

Table VIII. Distribution by subfield and employment offers for terminal masters, 1985–86.

Physics subfield	Total in subfield*	Percentage of graduates within subfield who received: 0 offers	1 offer	>2 offers
Acoustics	6.1%	18%	82%	–
Bio/medical physics	4.3	–	67	33%
Engr/applied physics	13.7	9	73	18
Geo/space physics	13.7	6	83	11
Nuclear	5.8	8	75	17
Optics, lasers	11.2	–	74	26
Solid state	21.3	27	58	15
General physics	7.2	–	80	20
All other subfields	16.7	7	80	13
Total	100.0%	12%	73%	15%
Employment-oriented respondents	224	27	163	34

* *Based on 277 respondents.*

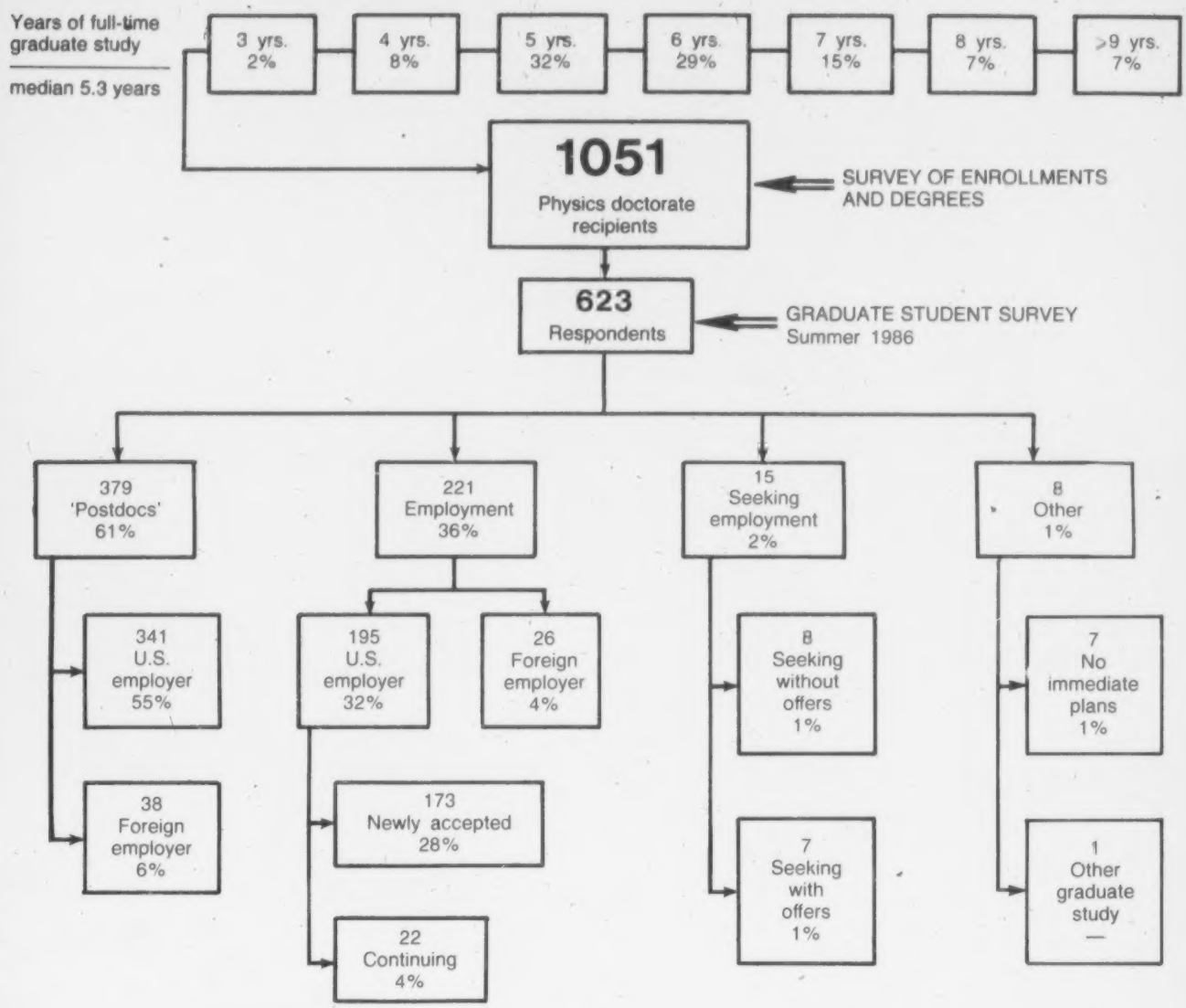
To examine the 224 employment-oriented masters in greater detail we present **Table VIII**, which expresses the demand in terms of the graduates' major areas of concentration. There is a tendency for physics masters to choose the more applied subfields such as optics or engineering physics. Acoustics, chosen by 6% of the respondents, appears to indicate a renewed interest. For the past six years the proportion of masters who specialized in acoustics in physics departments was so small that the annual listing of major subfields in this publication did not include it. The largest increase in one year was recorded for geo/space physics. In 1985, 4% of the masters had specialized in geo/space physics and all of the graduates had received offers; in 1986, almost 14% of the graduates chose that area of concentration and the demand for them, indicated in **Table VIII**, remained high.

Referred to in connection with **Figure II** and presented numerically in the last two rows of **Table VIII** is the assessment that the demand for new physics masters has recently declined. Two indications supporting this statement are: 1. Substantially fewer graduates reported multiple job offers to choose from, and 2. The proportion of new physics masters who entered the military service tripled between 1985 and 1986. **Table IX** identifies six types of employers including the military and links them to the major work activities reported. As in past years, industry remains the largest single employer where new masters perform engineering tasks as well as research and development activities. Although the proportion of new teachers among the masters has hardly changed, not one graduate reported a secondary school or junior college as his or her initial employer.

Table IX. Employment characteristics of 1985–86 recipients of physics master's degrees.

Work activity		Type of employer: University	4-yr college	Industry	Government	Military service	Nonprofit organization	Total N	Total %
Teaching		13	8	–	–	1	–	22	12
Research		3	1	6	2	1	1	14	7
Res. and dev.		–	–	23	6	31	3	63	33
Engineering		2	–	36	6	29	–	73	39
Comp. science		1	–	4	–	–	–	5	3
Nonphysics		–	–	10	–	–	2	12	6
Total	N	19	9	79	14	62	6	189	
	%	10	5	42	7	33	3		100%

Figure IV. Post-degree plans of physics doctorate degree recipients, 1985–86.



The flow diagram of **Figure IV** focuses on the 1985–86 physics doctorate recipients by highlighting and augmenting the data presented in **Tables I, VI** and **VII**. The wide range in the number of years required to complete a physics Ph.D. reflects the diversity of doctoral candidates at U.S. universities. Foreign students, some of whom enter at advanced levels of study, are not the only contributors to this diversity. Since undergraduate programs at U.S. colleges and universities range widely in quality, graduates from some of the less-demanding programs require additional years of graduate study. The major change in post-degree status involves the steady decline in the number of new doctoral physicists available to fill potentially permanent positions in the U.S. Details of this trend have been discussed in connection with **Table VII**. However, another factor that contributes to the sharp increase in 'postdocs' (12 percentage-points in the most recent year) is the attractiveness of these fellowships; they allow graduates to work in a research specialty of their choosing. Therefore, given the favorable employment outlook, new degree recipients need not be concerned about accepting temporary initial employment. Only 2% of the respondents were still seeking employment at the time of this survey and half of them reported offers that they had not yet decided to accept.

Table X. Use of physics in potentially permanent employment for graduate degree recipients, 1985–86.

	Major employer	Extensive use of physics training with respect to: method	subject matter	Number responding to question
Doctorate recipients	University	95%	78%	37
	Industry	78	67	81
	FFRC	94	82	17
	Government	76	73	22
	All employers	82%	72%	180

		Use of physics training with respect to subject matter: extensive	little	none	Number responding to question
Terminal masters	Educational inst.	67%	33%	–	24
	Industry	66	32	2%	76
	FFRC/Gov't.	88	12	–	76
	All employers	76%	23%	1%	181

When accepting potentially permanent employment the two groups of graduate degree recipients view the use of physics training differently. Doctorate recipients are concerned about working in their subfields as well as using the research methods they developed over several years. Terminal masters, who spend less time in graduate school, are primarily concerned about the extent to which they will utilize the subject of their specialization. The two parts of **Table X** summarize the responses from 180 doctoral physicists and 181 terminal masters. The major types of employers are listed for both groups and it appears that more doctoral physicists are making extensive use of the research methods than of their subject matter.

The reports from terminal masters show a substantial increase among those who are making extensive use of their physics specialty. Apparently, both industrial and government employers offer more suitable positions to physics masters while those whose initial employment was at an educational institution express a decreased degree of satisfaction.

For **Table XI** once again we exclude the 'postdocs' and foreign employers as we focus on new doctoral physicists who had accepted potentially permanent employment. In listing the traditional work activities along with engineering, we find that the proportion of graduates involved in engineering tasks has declined significantly: In 1980–81, 12% of the new physicists described their initial work activity as "engineering"; that proportion has steadily decreased so that only 5% fell into that category among the class of 1986.

Table XI. Initial employment with potential permanence for 1985–86 physics doctorate recipients.

Work activity		Type of employer: University	College	Industry	FFRC	Government	Other	Total N	Total %
Teaching		6	11	–	–	–	–	17	10
Research		7	–	20	11	8	4	50	29
Res. and teaching		20	7	–	–	–	–	27	16
Res. and dev.		2	–	50	3	6	–	61	35
Engineering		1	–	6	1	1	–	9	5
Other		1	–	3	1	2	2	9	5
Total	N	37	18	79	16	17	6	173	
	%	21	10	46	9	10	4		100%

Table XII. Median monthly starting salaries paid by U.S. employers to new physics degree recipients, 1986.

Type of employer	Bachelor's degree recipients		Terminal master's degree recipients		Doctorate recipients			
	Percentage accepting positions	Monthly starting salaries	Percentage accepting positions	Monthly starting salaries	Percentage accepting: 'Postdocs'	Potentially perm. pos.	Monthly starting sal. for: 'Postdocs'	Potentially perm. pos.
Secondary school	7%	$1350	1%	$1700	–	–	–	–
College	1	1530	5	1900	–	4%	–	$2000
University	3		10	1550	47%	7	$2040	2450
Industry	48	2240	32	2600	5	15	3080	3540
Gov't. inc. mil.	39	1625	43	2050	6	3	2300	3030
Fed. Funded Res. Ctr.	1	2100	3	2500	8	3	2150	3730
Other	1	1540	6	2200	1	1	–	3300
All employers	100%	$1900	100%	$2520	100%		$2050	$3180

Starting salaries presented in **Table XII** include only those paid by U.S. employers for newly accepted positions. Therefore the new physicists described in **Figures III** and **IV** as "continuing employment" are not included in this table. Doctoral physicists are divided into two groups because those starting potentially permanent employment are paid significantly higher salaries than those who accepted postdoctoral fellowships. For purposes of comparison, the starting salaries of physics bachelors were included in **Table XII** although they were not collected as part of the Graduate Student Survey. Thus four salaries are shown for the three levels of physics degree recipients.

The greatest change in median salary from the previous year was an 8% increase for the 'postdocs'; for several years their median salary had been lower than that paid to bachelors. Increases for the masters and doctors in potentially permanent positions were 5% and 2% respectively. The shift from industrial employment to the military among the physics bachelors resulted in a 4.5% decrease in their median monthly salary. Although industry pays some of the highest starting salaries, the highest median salary offered to doctorate recipients came from the Federally Funded Research Centers.

ASTRONOMY

Graduate astronomy students, enrolled in 47 universities in the U.S., are carefully selected from a pool of applicants eight times as large. Their number has remained around 700 for several years. Each year the graduate astronomy students are asked to contribute information to this survey which is presented in two tables and a flow diagram in this report. **Table XIII** relates the levels of graduate study to the major subfields in astronomy which include astrophysics, a subfield also listed among the physics subfields. By far the largest subfield is cosmology followed by stellar atmospheres and interstellar matter.

Table XIII. Graduate astronomy students* by subfield and years of graduate study, 1985–86.

		Full-time equivalent years of graduate study						Total	
		≤1 yr.	2 yrs.	3 yrs.	4. yrs.	5 yrs.	≥6 yrs.	N	%
Distribution of students	N	170	135	121	118	71	96	711	
	%	24%	19%	17%	16%	10%	14%		100%
Astronomy subfields									
Astronomical instruments and techniques		9%	9%	2%	7%	3%	3%	44	6%
Cosmology, extragalactic objects, quasi-stellar objects		21	24	21	18	30	29	166	23
Galactic structure, stellar motions		5	6	5	9	7	5	43	6
Interstellar matter and gaseous nebulae		10	13	13	14	10	16	90	13
Solar system, space astronomy of the solar system		7	1	5	11	7	8	46	6
Stellar atmospheres and spectra, stellar evolution, solar and stellar interiors		16	18	19	19	20	17	129	18
Supernovae, X, γ and cosmic rays, pulsars		5	3	6	6	3	3	32	5
The sun		3	–	1	2	5	3	16	2
Astrophysics		7	9	14	8	5	10	63	9
All other subfields combined		17	17	14	6	10	6	82	12
		100%	100%	100%	100%	100%	100%		

* *The percentages shown in this table are based on 486 respondents to the Graduate Student Survey. Astronomy department chairpersons reported a total of 711 graduate students for the survey of Enrollments and Degrees.*

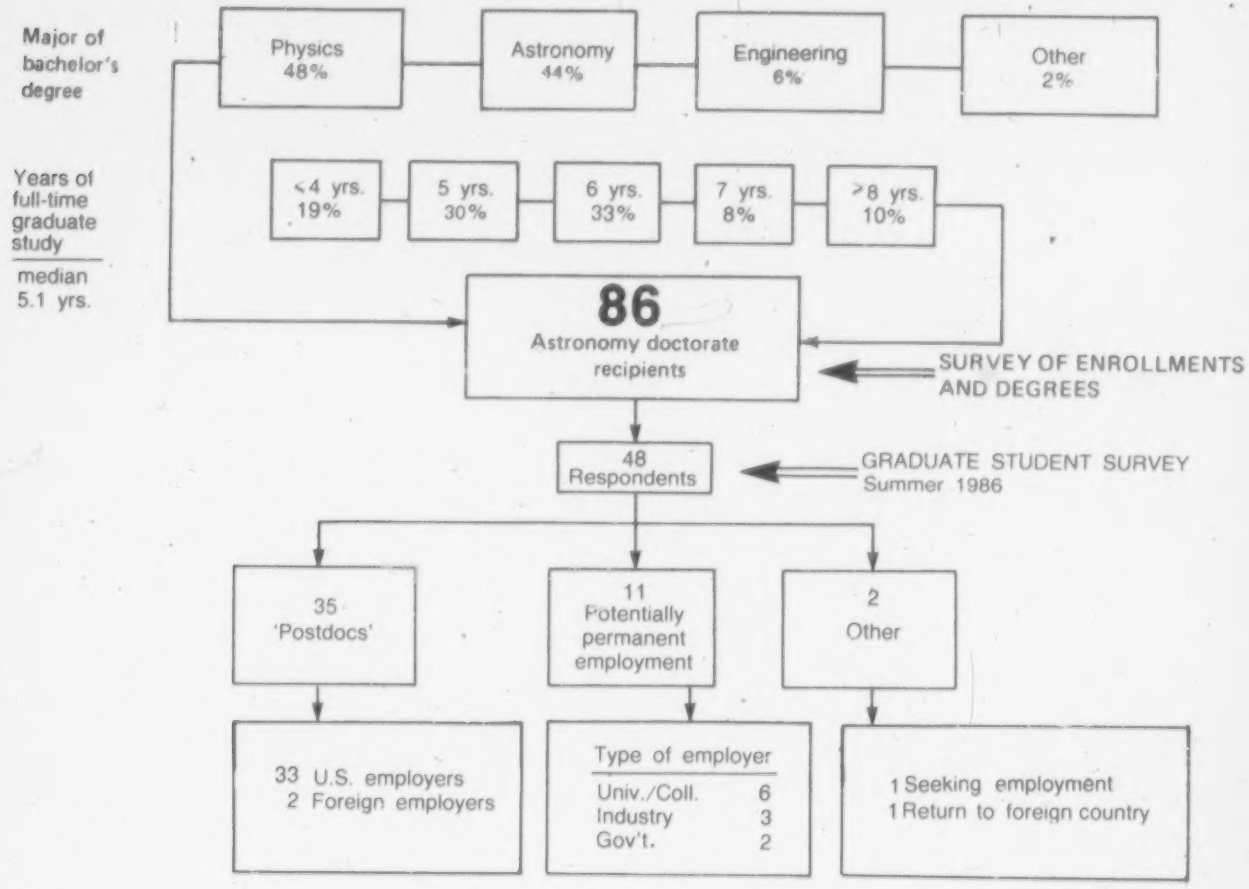
A majority of the graduate astronomy students majored in physics as undergraduates because only 56 astronomy bachelor's programs are available in the U.S. The format of **Table XIV** is similar to that of **Table I** to facilitate comparisons with the graduate physics students. Traditionally astronomy has always attracted a higher proportion of women and fewer foreign students; the 1985–86 survey indicates no changes along these lines. Examining the sources of support we find that a higher proportion of astronomy graduate students received fellowships than did physics graduate students.

Table XIV. Characteristics of the graduate astronomy student population, 1985–86.

Characteristics		All graduate students	First-year graduate students	Doctorate recipients
	*Total population:	711	170	86
	Number of respondents:	486	107	48
Sex	Female	19%	22%	7%
	Male	81	78	93
Citizenship	U.S.	76%	69%	83%
	Foreign	24	31	17
High school physics	Yes	91%	92%	92%
	No	9	8	8
Major of bachelor's degree	Astronomy	37%	38%	44%
	Physics	53	51	48
	Mathematics	2	3	–
	Other	5	5	2
Type of bachelor's institution	PhD granting	59%	60%	71%
	MS granting	4	–	4
	BS/BA granting	13	17	6
	Foreign	24	23	19
Type of graduate institution*	PhD granting	96%	95%	100%
	MS granting	4	5	–
Student status*	Full-time	95%	96%	96%
	Part-time	5	4	4
Source of support	Teaching assist.	30%	49%	4%
	Research assist.	46	22	64
	Fellowship	11	16	17
	Family, savings, loans	3	5	4
	Foreign government	3	4	2
	Other	7	4	9
Major subfields	Cosmology	23%	22%	19%
	Interstellar matter	13	10	17
	Solar system	6	8	8
	Stellar atmos. & spectra	18	15	21
	Astrophysics	9	7	13

* *These data were reported by astronomy department chairpersons as part of the survey of Enrollments and Degrees.*
Note: A total of 24 terminal master's degrees were granted and only 8 responses received.

Figure V. Background characteristics and post-doctorate status of 1985-86 astronomy graduates.



Comparing the time required to complete an astronomy doctorate with that required by physicists we find in **Figure V** that 19% of the astronomers, compared with 10% of the physicists, took at most four years. To add to the characteristics of **Table XIV**, **Figure V** shows the postdoctorate employment status of the new astronomers, most of whom traditionally accept 'postdocs'.